



The Partner For Success

**ZUKEN**<sup>®</sup>

# IBIS [Model Selector] Improvement Proposal

Michael Schäder  
EMC Technology Center  
Paderborn Germany

Bob Ross  
Teraspeed Labs  
USA

European IBIS Summit  
May 25, 2018  
Brest, France



## IBIS Files have become large and more complicated over time

Year	Description	# Components	#Models	#Pins	File Size	IBIS Version
1995	4 Mb programmable DRAM controller	1	9	100	142 kb	1.1
1998	MCU 40 MHz, 16-bit, 32 kb	1	7	100	169 kb	2.1
2002	512 Mb SDRAM	1	2	54	52 kb	3.2
2008	1 Gb DDR2 SDRAM	3	33	100	1,570 kb	4.0
2015	8 GB LPDDR4 SDRAM	4	137	200 - 432	15,550 kb	4.2
	(same as above, but power aware models)				28,120 kb	5.0
2017	automotive Ethernet switch	1	203	128	8.920 kb	3.2

- Even much larger IBIS files exist (biggest seen ~340 MB)
  - Requires a robust editor (e.g., vi, emacs, notepad++)
  - Difficult to handle when modifications or adjustments are required
  - Causes long processing times

## Issues in application

- Several components included in a single IBIS file
  - Break down / modify IBIS file so that only the actually required component remains
  - Remove unused components, packages, and models from the original IBIS file
- Several speed levels, supply voltages, and ODTs are included in a single IBIS file
  - Most often realized by means of [Model Selector]s
  - Ensure the desired models are used in simulation
    - Put the desired model in the first line
  - Make all relevant models available e.g., to enable series simulation with different ODTs
    - EDA tool and simulator dependent
    - Keep only relevant models in the [Model Selector]

```
cmp_example.txt
File Edit Options Buffers Tools Text Help
| Part Number  VDD/VDDQ  Architecture  Package
|-----|-----|-----|-----|
| nnnn_M32D1GZ  1.10/1.10  256M x 32    WFBGA (200b,SDP,11x14.5x0.8)
| nnnn_M64D2NH  1.10/1.10  256M x 64    WFBGA (272b,DDP,15x15x0.7)
| nnnn_M64D2NW  1.10/1.10  256M x 64    VFBGA (432b,DDP,15x15x0.85)
| nnnn_M32D1    1.10/1.10  256M x 32    BareDie
|*****|
|1\---  cmp_example.txt  All L1  (Text)
```

```
mdl_sel_example.txt
File Edit Options Buffers Tools Text Help
[Model Selector] nnn #192 models
|
|For the following output pad, V18=1, V25=0, VDDO=1.8V
nnn_SR0_18_20 zzz_PUPD_EN with ZPR/ZNR=0000, SR=0
[...]
#12 supply conditions
|For the following output pad, V18=0, V25=1, VDDO=2.5V
nnn_SR0_25_20 zzz_PUPD_EN with ZPR/ZNR=0000, SR=0
[...]
|
|For the following output pad, V18=0, V25=0, VDDO=3.3V
[...]
nnn_SR3_33_Z15 zzz_PUPD_EN with ZPR/ZNR=1111, SR=3
|1\---  mdl_sel_example.txt  All L6  (Text)
```

# Prepare IBIS Files for Simulation

- Select model or groups of models as needed
  - Requires some more insight into the IBIS file
  - Can be difficult with really large files with many models and large [Model Selector]s
- EDA software might help
  - May help to break down IBIS data
  - May allow selection of components and models at some stage towards simulation

Whatever software is able to do, many users feel uncomfortable digging that much into IBIS and IBIS files

The screenshot displays the IBIS Development Studio interface with several key components:

- Pin Data Table:** A table listing pins, their differences, signals, models, and model information.
 

Pin	Difference	Signal	Model	Model Information
82		C_LED[3]	DCIOBLEDP50	Selector: DCLEDP50_18_LED0,... and 23 more
83		RESETn	mssel2	Selector: mmm2_18,... and 2 more
84		VDD	POWER	
85		TRACESWO	DCHSOUT2	Selector: mmm_SR0_18_Z0,... and 191 more
86		TRACEDATA[3]	DCHSOUT2	Selector: mmm_SR0_18_Z0,... and 191 more
87		VDDO	POWER	
88		TRACEDATA[2]	DCHSOUT2	Selector: mmm_SR0_18_Z0,... and 191 more
89		TRACEDATA[1]	DCHSOUT2	Selector: mmm_SR0_18_Z0,... and 191 more
90		TRACEDATA[0]	DCHSOUT2	Selector: mmm_SR0_18_Z0,... and 191 more
91		TRACECLK	DCHSOUT2	Selector: mmm_SR0_18_Z0,... and 191 more
92		VDDO	POWER	
93		AVDD_PLL	POWER	
94		XTAL_2	nomodel	Terminator
95		AVSSC	nomodel	Terminator
96		XTAL_1	nomodel	Terminator
97		WAKE_IN	nomodel	Terminator
98		INH	nomodel	Terminator
99		VBATR	nomodel	Terminator
100		VBATF	nomodel	Terminator
101		TSTPT	nomodel	Terminator
102		RSET	nomodel	Terminator
103		HSDACP	nomodel	Terminator
- Assign Model Dialog:** A dialog box for selecting a model. The 'Filter' field is empty. The table below shows the available models.
 

Model	Type	Aux.	Condition
mmm_SR0_18_Z8	Output		typ/bc/wc
mmm_SR0_18_Z9	Output		typ/bc/wc
mmm_SR0_25_Z0	Output		typ/bc/wc
mmm_SR0_25_Z1	Output		typ/bc/wc
mmm_SR0_25_Z10	Output		typ/bc/wc
mmm_SR0_25_Z11	Output		typ/bc/wc
mmm_SR0_25_Z12	Output		typ/bc/wc
mmm_SR0_25_Z13	Output		typ/bc/wc
mmm_SR0_25_Z14	Output		typ/bc/wc
mmm_SR0_25_Z15	Output		typ/bc/wc
mmm_SR0_25_Z2	Output		typ/bc/wc
mmm_SR0_25_Z3	Output		typ/bc/wc
mmm_SR0_25_Z4	Output		typ/bc/wc
mmm_SR0_25_Z5	Output		typ/bc/wc
mmm_SR0_25_Z6	Output		typ/bc/wc
- Model Selector Table:** A table showing pin numbers, signal names, and model names.
 

Pin number	Signal name	Model Name	#	Typ	Pr
64	E4	DQS_A	DQ_PD40_ODTDIS_VOH30	74	
65	E5	VSS		0	
66	E8	VSS		0	
67	E9	DQ13_A	DQ_PD40_ODTDIS_VOH30	74	
E10	D10	DQS1_c_A	DQS_PD40_ODTDIS_VOH30	74	
69	E11	DQ10_A	DQS_PD40_ODTDIS_VOH30	74	
- Model Information Table:** A table showing electrical parameters for the selected model.
 

	Typical	Worst
VCC (V)	1.10000	1.06000
Rol/Roh (Ohm)	77.95/41.23	82.15/
Tr/Tf (ps)	58.5/78.77	66.61/
Cin (pF)	1.019	1.063
- Model Selector Text View:** A text-based view of the model selector, showing a list of models and their parameters.
 

```

2301 [Model Selector] DQS
2302 |
2303 DQS_PD40_ODTDIS_VOH30 40 Ohm Pulldown, No System O
2304 DQS_PD48_ODTDIS_VOH30 48 Ohm Pulldown, No System O
2305 DQS_PD60_ODTDIS_VOH30 60 Ohm Pulldown, No System O
2306 DQS_PD80_ODTDIS_VOH30 80 Ohm Pulldown, No System O
2307 DQS_PD120_ODTDIS_VOH30 120 Ohm Pulldown, No System O
2308 DQS_PD240_ODTDIS_VOH30 240 Ohm Pulldown, No System O
2309 DQS_PD40_ODT40_VOH30 40 Ohm Pulldown, 40 Ohm Syste
2310 DQS_PD48_ODT40_VOH30 48 Ohm Pulldown, 40 Ohm Syste
2311 DQS_PD60_ODT40_VOH30 60 Ohm Pulldown, 40 Ohm Syste
2312 DQS_PD80_ODT40_VOH30 80 Ohm Pulldown, 40 Ohm Syste
2313 DQS_PD120_ODT40_VOH30 120 Ohm Pulldown, 40 Ohm Syste
2314 DQS_PD240_ODT40_VOH30 240 Ohm Pulldown, 40 Ohm Syste
            
```

# Existing [Model Selector]

## Existing [Model Selector]

- Description: Used to pick a [Model] from a list of [Model]s for a pin which uses a programmable buffer  
Example:

[Pin]	signal_name	model_name	R_pin	L_pin	C_pin
1	RAS0#	Progbuffer1	200.0m	5.0nH	2.0pF
2	EN1#	Input1	NA	6.3nH	NA
4	D1	Progbuffer2	320.0m	3.1nH	2.2pF
6	D2	Progbuffer2	290.0m	3.0nH	2.1pF
...					

```
[Model Selector]          Progbuffer1
| model_name  description
OUT_4         4 mA buffer without slew rate control
OUT_8         8 mA buffer without slew rate control
OUT_4S        4 mA buffer with slew rate control
OUT_6S        6 mA buffer with slew rate control
```

```
[Model Selector]          Progbuffer2
|
OUT_6S        6 mA buffer with slew rate control
OUT_8S        8 mA buffer with slew rate control
OUT_4         4 mA buffer without slew rate control
OUT_6         6 mA buffer without slew rate control
OUT_8         8 mA buffer without slew rate control
```

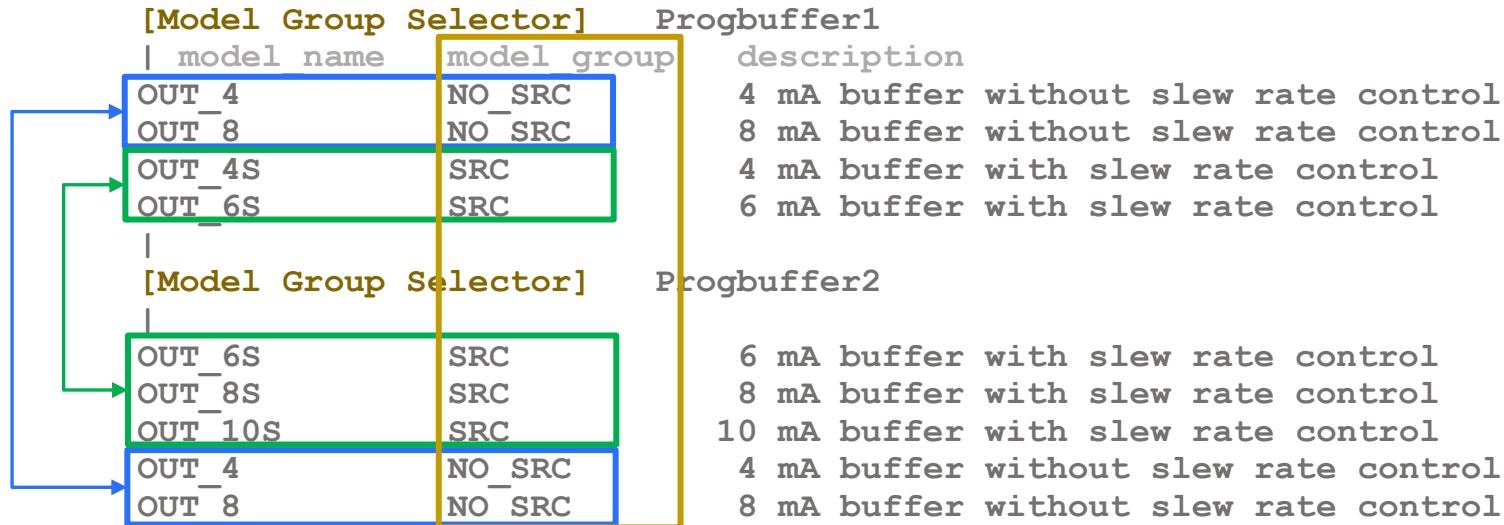


## New IBIS keyword [Model Group Selector]

- Description: Used to define groups of [Model]s supporting a correlated model selection from a list of models for pins  
Example I:

[Pin]	signal_name	model_name	R_pin	L_pin	C_pin
1	RAS0#	Progbuffer1	200.0m	5.0nH	2.0pF
2	EN1#	Input1	NA	6.3nH	NA
4	D1	Progbuffer2	320.0m	3.1nH	2.2pF
6	D2	Progbuffer2	290.0m	3.0nH	2.1pF
...					

- Allows to define groups of models, e.g., for different operating conditions
- Groups are supposed to be consistently defined within an IBIS file and supported across all [Model Group Selector]s



## New IBIS keyword [Model Group Selector]

- Example II:

[Pin]	signal_name	model_name	R_pin	L_pin	C_pin
1	RAS0#	Progbuffer1	200.0m	5.0nH	2.0pF
2	EN1#	Input1	NA	6.3nH	NA
4	D1	Progbuffer2	320.0m	3.1nH	2.2pF
6	D2	Progbuffer2	290.0m	3.0nH	2.1pF
...					

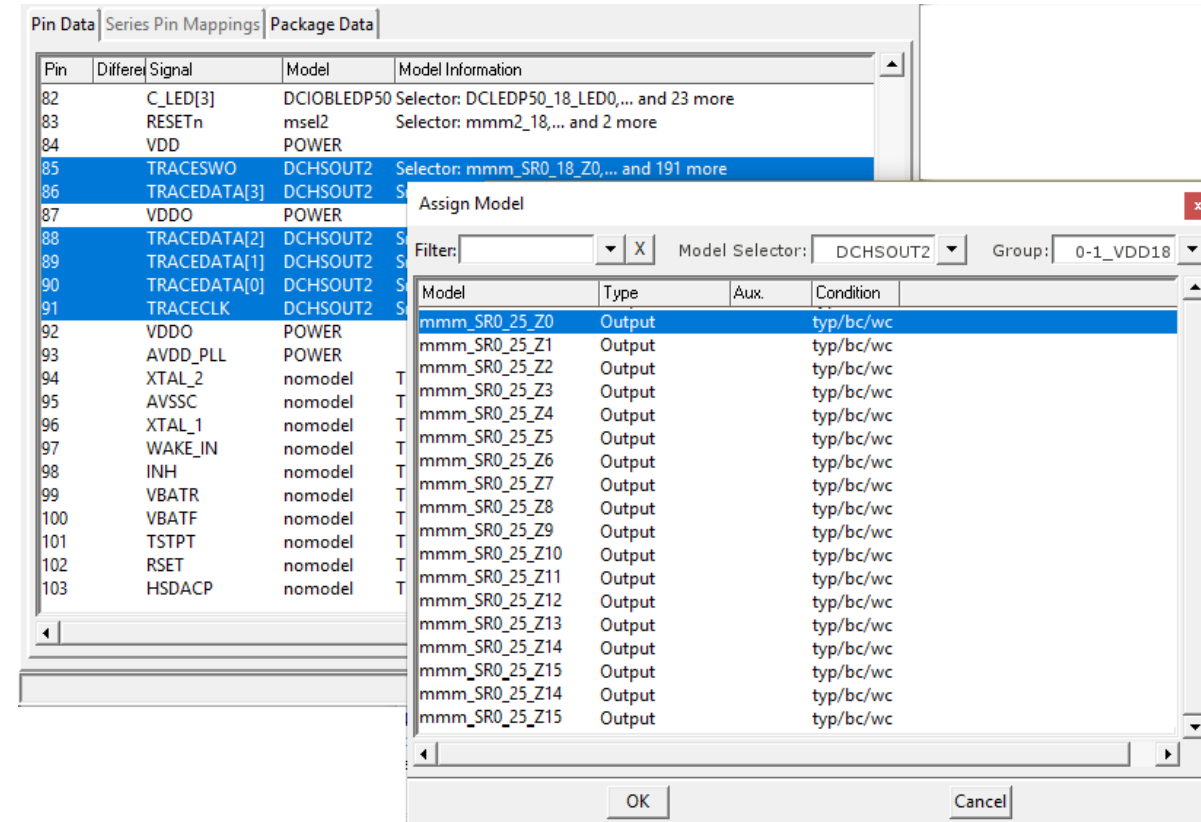
- Allows to define operating condition specific sets of models throughout the IBIS file

[Model Group Selector]	Progbuffer1	
model name	model group	description
OUT_4	NO SRC 4	4 mA buffer without slew rate control
OUT_8	NO SRC 8	8 mA buffer without slew rate control
OUT_4S	SRC L	4 mA buffer with slew rate control
OUT_6S	SRC H	6 mA buffer with slew rate control
[Model Group Selector]	Progbuffer2	
OUT_6S	SRC L	6 mA buffer with slew rate control
OUT_8S	SRC H	8 mA buffer with slew rate control
OUT_10S	SRC H	10 mA buffer with slew rate control
OUT_4	NO SRC 4	4 mA buffer without slew rate control
OUT_8	NO SRC 8	8 mA buffer without slew rate control

- Advantages of [Model Group Selector]
  - Clear mapping of groups of models to operation conditions
  - Enables correlated model selections
  - Allows driving more advanced model selections
  - Allows specifying and using model groups in series simulations
  - Can reduce the need to edit the original IBIS file
  - Can coexist with existing [Model Selector]

- Propose a BIRD for [Model Group Selector]

- Depending on the feedback and support
- Happy to do this with others who want to support the [Model Group Selector]





# Further Improvements to Simplify IBIS Application

- What model makers can do
  - Prepare separate IBIS files for different application conditions
  - Use model names which following an obvious naming schema
  - Use meaningful descriptions in [Model selector]s
  - Make IBIS files consistent with data sheets, e.g., regarding buffer names, packages, signal names, etc.
- What software vendors can do
  - Not much more – software is almost perfect 😊😊😊
  - Find smarter ways to present IBIS data for application
  - Allow flexible IBIS configuration with an intuitive user interface

- IBIS files grow in size and complexity
  - More data, better data
  - Smarter semiconductors require better modeling
  - Better modeling requires enhanced modeling capabilities (which drives IBIS)
- Software is often helpful
- IBIS files can be improved
- [Model Group Selector] can be a part simplifying IBIS application
  - Can help EDA vendors and model makers, and thus our mutual users



**ZUKEN<sup>®</sup>**

**Thank you!**

**Questions?**